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REMEDIAL ACTION PLAN
FOR EXPANDED BIOVENTING SYSTEM
AT SITE FC-2
KELLY AFB, TEXAS

Prepared for:

AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE
BROOKS AFB, TEXAS
AND
SAN ANTONIO AIR LOGISTICS CENTER/EMR
KELLY AFB, TEXAS

JANUARY 1996

Prepared by:

PARSONS ENGINEERING SCIENCE, INC.
DENVER, COLORADO

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FOR EXPANDED BIOVENTING SYSTEM
AT SITE FC-2
KELLY AFB, TEXAS

Prepared for:

AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE
BROOKS AFB, TEXAS
AND
SAN ANTONIO AIR LOGISTICS CENTER/EMR
KELLY AFB, TEXAS

DECEMBER 1995

Prepared by:

PARSONS ENGINEERING SCIENCE, INC.
DENVER, COLORADO

REMEDIAL ACTION PLAN
FOR EXPANDED BIOVENTING SYSTEM
AT SITE FC-2
KELLY AFB, TEXAS

Prepared for:

AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE
BROOKS AFB, TEXAS
AND
SAN ANTONIO AIR LOGISTICS CENTER/EMR
KELLY AFB, TEXAS

JANUARY 1996

Prepared by:

PARSONS ENGINEERING SCIENCE, INC.
DENVER, COLORADO

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INTRODUCTION

This remedial action plan presents the scope for an expanded bioventing system for *in situ* treatment of fuel-contaminated soils at a former fire control training area referred to as Site FC-2 at Kelly Air Force Base (AFB), Texas. The proposed expanded system activities will be performed by Parsons Engineering Science, Inc. (Parsons ES) for the Air Force Center for Environmental Excellence (AFCEE) Technology Transfer Division (ERT) under contract F41624-92-D-8036, 0017. The primary objectives of the system upgrade are:

- To deliver oxygen to contaminated subsurface soil throughout the site;
- To provide additional characterization data for closure in accordance with Texas risk reduction rules;
- To continue aerobic *in situ* remediation of fuel-contaminated soils by injection of atmospheric air into soil; and
- To sustain aerobic *in situ* biodegradation until hydrocarbon-contaminated soils within the unsaturated zone are remediated to below regulatory approved standards.

A one-year bioventing pilot test was performed at this site from December 1992 to January 1994 to determine if *in situ* bioventing would be a feasible cleanup technology for the fuel-contaminated soils within the unsaturated zone in the source area. A radius of oxygen influence of at least 35 feet was observed at 4, 9, and 13.5-foot depths, at an average flow rate of 48 cubic feet per minute (cfm) during the initial pilot test. Based on 6- and 12-month testing results, the actual radius of oxygen influence was estimated to be 50 feet. Further detail on the pilot test procedure and results can be found in the Interim Pilot Test Results Report (Parsons ES, 1993).

Following the one-year pilot test, soil and soil gas data confirmed significant contaminant removal in the entire pilot test area. Based on laboratory results from soil and soil gas samples taken from the most contaminated areas, reduction in soil gas concentrations of total volatile hydrocarbons (TVH) and total benzene, toluene, ethylbenzene, and xylenes (BTEX) was greater than 97 percent across the site. Total recoverable petroleum hydrocarbon (TRPH) concentrations in soil were reduced by approximately 90 percent or more in the vent well (VW), MPA, and MPC during the 1 year pilot study. BTEX concentrations were reduced by almost 100 percent in all 3 measured points. The success of bioventing at this site supports the recommendation of

an expanded bioventing system as the most economical approach of remediating the remaining hydrocarbon-contaminated soils within the source area.

Pilot test data have been used to design the expanded bioventing system to remediate contaminated soils at Site FC-2 to regulatory standards. The expanded system will consist of the existing air injection VW, four newly constructed VWs, and conversion of two groundwater monitoring wells (MW) into air injection wells, to deliver oxygen throughout the remaining areas of unsaturated fuel-contaminated soils. Three new vapor monitoring points (MPs) will also be constructed to monitor for contaminant reduction and oxygen influence in the soil gas.

This document is divided into eight sections including this introduction. Section 2 discusses site background and includes a discussion of existing characterization data. Section 3 provides the results of the one-year pilot test conducted at Site FC-2. Section 4 identifies the treatment area of the proposed expanded system; provides construction details of the expanded system; and recommends a proven, cost-effective approach for the remediation of the remaining hydrocarbon-contaminated soils within the source area at the site. Investigation derived waste procedures are described in Section 5, and base support requirements are listed in Section 6. Section 7 provides key points of contact at Kelly AFB, AFCEE, and Parsons ES; and Section 8 provides the references cited in this document. A design package for the expanded bioventing system is provided in the appendix.

SECTION 2
SITE BACKGROUND

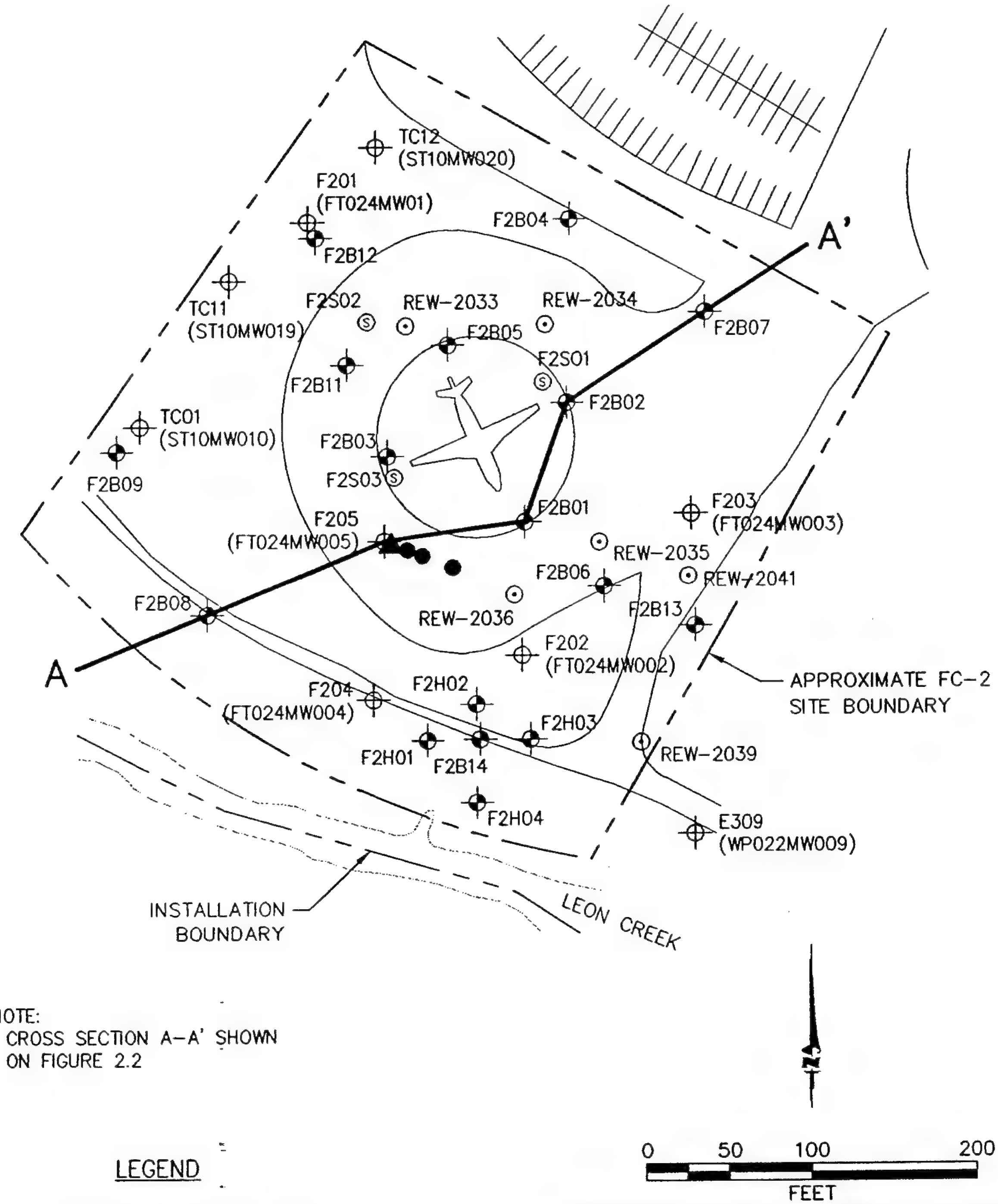
2.1 HISTORY OF SITE FC-2

Site FC-2 consists of a circular area approximately 150 feet in diameter located northwest of the Industrial Waste Sludge Lagoon (Site SA-2) and approximately 100 feet north of Leon Creek. The site layout is presented in Figure 2.1. The area was used from the 1950's to 1981 for fire control training exercises. Waste petroleum, oil, and lubricants (POLs), and fuels were set on fire near the simulated airplane at the center of the site two to four times a year. The fires were extinguished with a water/protein mixture or an aqueous, film-forming foam. No collection facility or oil/water separator (OWS) was used to stop direct infiltration of fuel into the ground. Before any field investigations were performed, the site was regraded with fill material consisting of soils collected from various locations around the base.

2.2 SITE GEOLOGY AND HYDROGEOLOGY

Because the bioventing technology is applied to the unsaturated soils, this section will primarily address soils above the shallow aquifer. A geologic cross section of the site is shown on Figure 2.2 (orientation is on Figure 2.1). Eight to 22 feet of fill material is present over most of Site FC-2 (NUS, 1992). This material is poorly sorted, brown clay to clayey gravel with minor amounts of caliche, sand, and silt. Traces of wood, glass, metal, wire, and assorted construction materials were also encountered. Surficial materials in the top 8 feet consist of fill materials or undisturbed silts and clays. Below these surficial soils, groundwater is encountered in coarse grained sands, gravels or clayey gravels at varying depths of 15 to 18 feet below ground level (bgl). The Navarro clay, a blue-gray to orange brown, mottled dense plastic clay, underlies the coarse-grained sands and gravel. The thickness of the water bearing alluvial/fill material formation ranges from 1 to 11 feet. The soil types across the site appear to be well suited for bioventing treatment by air injection.

Groundwater at Site FC-2 is encountered in the lower coarse-grained sediments described previously, above a thick clay layer of the Navarro formation. The hydraulic gradient at the site is very low, averaging 0.0011 horizontal feet per vertical foot (ft/ft). Groundwater flow in this area is south-southwesterly toward Leon Creek. Slug test data reported by NUS indicates an average hydraulic conductivity of 1.78 x 10^{-1} centimeters per second (cm/sec) for the alluvial aquifer. Using the average hydraulic conductivity value and assuming an effective porosity of 30 percent, the average seepage flow velocity was calculated to be 1.29 feet per day (ft/day) (NUS, 1992). The northwest to southeast trending Navarro high underlying FC-2 results in significant lateral changes in the



LEGEND

- EXISTING MONITORING WELL
- EXISTING BIOVENTING MONITORING POINT
- EXISTING VENT WELL
- SURFACE SOIL SAMPLE
- INSTALLED SOIL BORING
- GEOPROBE SAMPLE LOCATIONS

FIGURE 2.1

SITE LAYOUT AND GEOLOGIC CROSS SECTION ORIENTATION

Remedial Action Plan
Site FC-2
Kelly AFB, Texas

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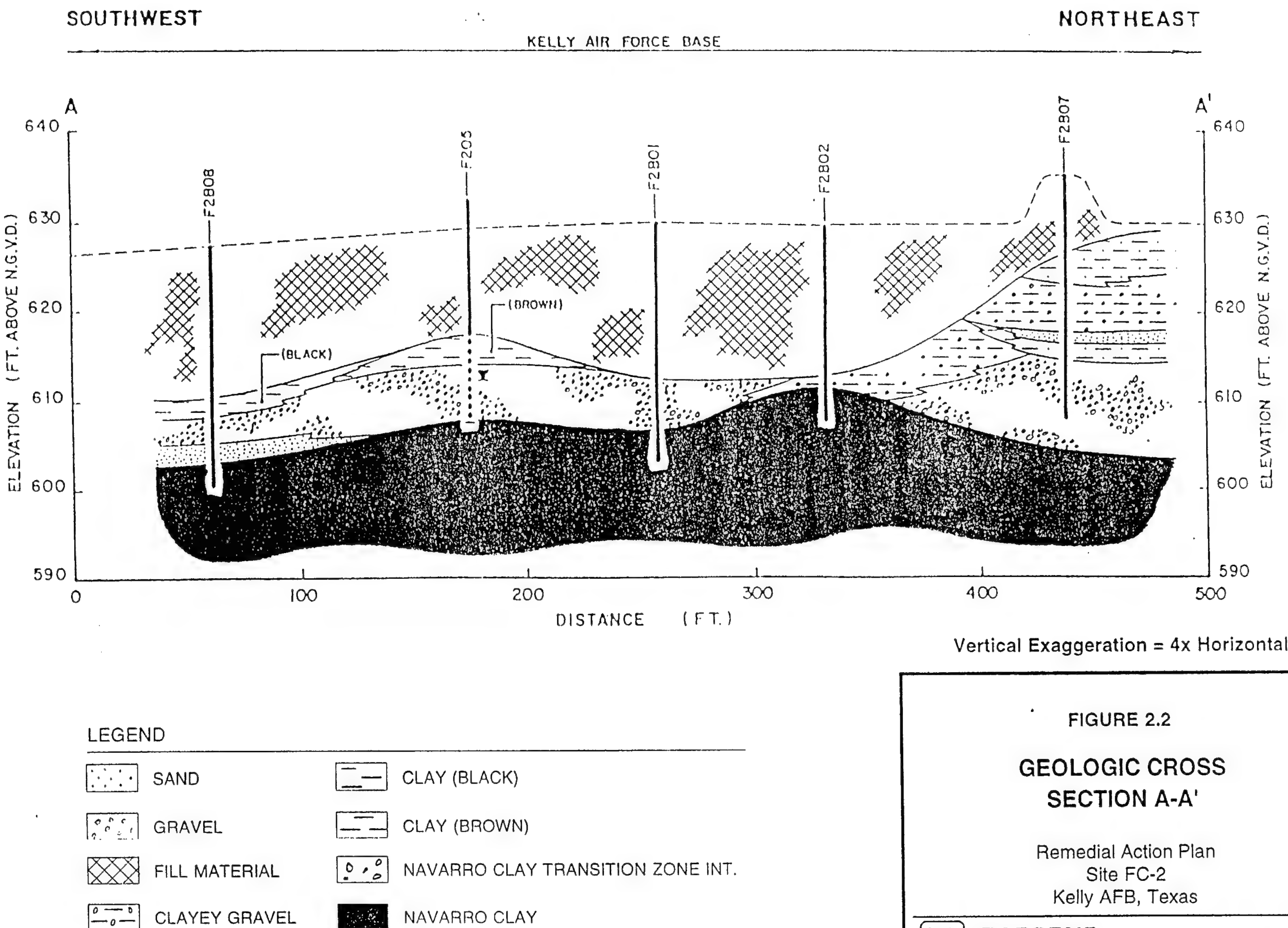

FIGURE 2.2

GEOLOGIC CROSS SECTION A-A'

Remedial Action Plan
Site FC-2
Kelly AFB, Texas

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

Source: Haliburton Nus, 1991.

saturated thickness of the alluvial aquifer. The thickness of the saturated zone ranges from 4.5 feet (F205) to 15.6 feet (F204). The Navarro Clay acts as a low permeable barrier to vertical migration for the shallow alluvial groundwater, so the primary migration pathway is to Leon Creek.

2.3 SITE CONTAMINANTS

An initial site investigation was conducted by Radian Corporation in 1986. As part of that investigation, Radian drilled three shallow soil borings and collected soil samples from 1 to 2 feet bgl and 4 to 5 feet bgl in each boring. Radian then installed three MWs, F201 (FT024MW001), F202 (FT024MW002), and F203 (FT024MW004), at these boring locations. The findings of the study are included in the Phase II, Stage 2 report (Radian 1988). One shallow soil sample collected from F203 contained trichloroethylene (TCE) at 0.016 milligrams per kilograms (mg/kg) of soil. TRPH contamination ranged from 250 to 10,000 mg/kg in shallow samples, and from 320 to 1300 mg/kg in deeper samples. Petroleum hydrocarbons were detected in all soil samples, to a maximum concentration of 10,000 ppm. A visible sheen of floating product was also encountered on the groundwater at F202. Furthermore, concentrations of some metals were detected at levels above the reported groundwater background levels in the three monitoring wells. Radian's soil investigation assessed soils in the top 5 feet at the site. The position of these sample locations are shown on Figure 2.1.

Roy F. Weston, Inc. collected 13 soil samples in 1990 located within 30 feet of the simulated airplane. These samples were collected throughout the vertical profile of subsurface soils at the site. Low levels of organic compounds were detected in each soil boring. Sample results are included on Table 2.1. Sample depths were not able to be determined using available boring logs or analytical data reporting sheets, so they are not included on the table. Only four sample results were reviewed. The results of this work are presented in the IRP Site Characterization and Permitting for Sites E-3 and FC-2 (Weston 1990).

In 1991, NUS performed a soil gas survey, installed 2 permanent monitoring wells F204 (FT024MW004) and F205 (FT024MW005), drilled 13 soil borings, completed 4 shallow hand auger borings, and collected 3 surface-soil samples to further define contamination at the site. Laboratory results, also listed on Table 2.1, indicated that much of the VOC, BNA and TPH contamination exists near the center of the fire training area within 100 feet of the simulated plane. Distribution of contamination detected in soil samples from the site is sporadic, with some borings located within 20 feet of each other containing significantly different levels of contamination. These results suggest that contamination may not be uniformly distributed at the site.

Additional soil samples were collected in August-September 1995 by R.E. Wright Environmental, Inc. A geoprobe sampler was used to further characterize soils at the site. Samples were analyzed using a portable gas chromatograph. A preliminary data report has been provided to Parsons ES for incorporation into this plan (R.E. Wright Environmental, 1995). This data is included on Table 2.1, but only includes those

Table 2.1
Summary of Organic Compounds in Soil at Site FC-2
Kelly AFB, Texas

Parameters	Risk Reduction[1] Rule Standard #2	Sample ID concentrations in milligrams per kilograms (mg/kg)												
		FC-2-2(1-2)[R]	FC-2-1(4-5)[R]	FC-2-2(1-2)[R]	FC-2-2(4-5)[R]	FC-2-3(1-2)[R]	FC-2-3(4-5)[R]	FC2-SB56[W]	FC-2-SB57[W]	FC-2-SB58[W]	FC2-SB59[W]	F205[N]	F2B01	F2B03
Methylene chloride	0.5	ND	ND	ND	ND	ND	ND	<0.026	1.0B	0.52JB	0.28B	ND	ND	ND
Acetone	365	ND	ND	ND	ND	ND	ND	0.200	2.1B	2.1B	0.50	0.310J	ND	ND
1,2-dichloroethylene	1	ND	ND	ND	ND	ND	ND	0.011	<0.63	<0.72	0.01J	ND	ND	ND
2-butanone (MEK)	183	ND	ND	ND	ND	ND	ND	<0.052	<1.3	<1.4	<0.02	0.078J	0.011J	ND
Benzene	0.5	ND	ND	ND	ND	ND	ND	<0.026	<0.63	<0.72	<0.01	ND	0.002J	ND
1,1,1-trichloroethane	20	ND	ND	ND	ND	ND	ND	0.023	<0.63	<0.72	<0.01	ND	ND	ND
Toluene	100	ND	ND	ND	ND	ND	ND	0.44J	<0.63	10	0.5J	ND	ND	ND
Chlorobenzene	10	ND	ND	ND	ND	ND	ND	<0.65	<0.63	<0.72	<1.2	ND	0.004J	ND
Ethyl benzene	70	ND	ND	ND	ND	ND	ND	<0.65	<0.63	<0.72	<1.2	ND	0.002J	ND
Xylene	1,000	ND	ND	ND	ND	ND	ND	<0.65	<0.63	<0.72	<1.2	ND	0.007	ND
Trichloroethylene	0.5	<0.0006	<0.0006	<0.0006	0.016	<0.0006	<0.0006	0.017	<0.63	0.35J	0.016	ND	ND	ND
1,4-dichlorobenzene	7.5	ND	ND	ND	ND	ND	ND	<0.65	3.3	<0.72	<1.2	ND	ND	ND
1,2-dichloro benzene	60	ND	ND	ND	ND	ND	ND	<0.65	<0.63	<0.72	<1.2	ND	ND	ND
Naphthalene	146	ND	ND	ND	ND	ND	ND	<0.38	0.86J	<21	<0.74	ND	0.024J	ND
2-methyl naphthalene	not listed	ND	ND	ND	ND	ND	ND	0.12J	1.6J	<21	<0.74	15.0J	ND	0.130J
Fluoranthene	146	ND	ND	ND	ND	ND	ND	<0.38	<2.0	<21	<0.74	ND	0.087J	ND
Pyrene	110	ND	ND	ND	ND	ND	ND	0.11J	0.40J	<21	<0.74	0.0675J	0.084J	ND
Acenaphthene	219	ND	ND	ND	ND	ND	ND	<0.38	<2.0	<21	<0.74	ND	ND	ND
Di benzo furan	not listed	ND	ND	ND	ND	ND	ND	<0.38	<2.0	<21	<0.74	0.170J	ND	ND
Di ethyl phthalate	2,920	ND	ND	ND	ND	ND	ND	<0.38	<2.0	<21	<0.74	ND	0.019J	ND
phenanthrene	not listed	ND	ND	ND	ND	ND	ND	0.080J	<2.0	<21	<0.74	0.099J	0.043J	ND
Anthracene	1,100	ND	ND	ND	ND	ND	ND	<0.38	<2.0	<21	<0.74	ND	ND	ND
Di-n-butyl phthalate	365	ND	ND	ND	ND	ND	ND	<0.38	<2.0	<21	<0.74	0.0325	ND	ND
Fluorene	146	ND	ND	ND	ND	ND	ND	0.086J	0.23J	<21	<0.74	0.190J	ND	ND
3,3-dichlorobenzidine	not listed	ND	ND	ND	ND	ND	ND	<0.58	<2.9	<21	<0.74	ND	ND	ND
Benzo(a)anthracene	not listed	ND	ND	ND	ND	ND	ND	<0.38	<2.0	<21	<0.74	ND	0.056J	ND
Chrysene	not listed	ND	ND	ND	ND	ND	ND	0.12J	<2.0	<21	<0.74	ND	0.063J	ND
bis(2-ethylhexyl)phthalate	0.608	ND	ND	ND	ND	ND	ND	<0.38	3.2	<21	<0.74	ND	ND	ND
Benzo(b)fluoranthene	not listed	ND	ND	ND	ND	ND	ND	<0.38	<2.0	<21	<0.74	ND	ND	ND
Benzo(a)pyrene	not listed	ND	ND	ND	ND	ND	ND	<0.38	<2.0	<21	<0.74	ND	ND	ND
Benzo(g,h,i)perylene	not listed	ND	ND	ND	ND	ND	ND	<0.38	<2.0	<21	<0.74	ND	ND	ND
Indeno(1,2,3-cd)pyrene	not listed	ND	ND	ND	ND	ND	ND	<0.38	<2.0	<21	<0.74	ND	ND	ND
Total petroleum hydrocarbon	nonspecific	10,000	400	250	1,300	1,800	320	Not tested	Not tested	Not tested	Not tested	2300	290	9

1GWP-Groundwater Protection-Residential
2ND-not detected, detection limit not available in copies of reference reports
(J)-estimated value
(B)-blank interference

W-Roy F. Weston data
R-Radian data
N-NUS data
G-RE Wright geoprobe data

Table 2.1, continued
Summary of Organic Compounds in Soil at Site FC-2
Kelly AFB, Texas

Parameters	Risk Reduction1 Rule Standard #2	F2B04N	F2B06N	F2B07N	F2B08N	B2B09N	F2B11N	F2B12N	F2B13N	F2B14N	F2S01N	F2S02N	F2S03N
		Sample ID, concentrations in milligrams per kilograms (mg/kg)											
Methylene chloride	0.5	ND	ND	ND	ND	ND	ND	ND	0.12	0.037	ND	ND	ND
Acetone	365	ND	0.73J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-dichloroethylene	1	ND	ND	ND	ND	MD	ND	0.003J	ND	ND	ND	ND	ND
2-butanone (MEK)	183	ND	0.140J	ND	ND	0.018J	ND	ND	ND	ND	ND	ND	ND
Benzene	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,1-trichloroethane	20	ND	ND	ND	ND	ND	ND	ND	ND	0.016	0.054	ND	0.034
Toluene	100	ND	ND	ND	ND	0.019	0.15	0.021J	0.28	ND	ND	ND	ND
Chlorobenzene	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethyl benzene	70	ND	0.12	ND	ND	0.0009J	ND	ND	ND	ND	ND	ND	ND
Xylene	1,000	ND	0.24	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trichloroethylene	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,4-dichlorobenzene	7.5	ND	0.29J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-dichloro benzene	60	ND	0.18J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Naphthalene	146	ND	1.5	ND	ND	ND	ND	0.032J	ND	ND	ND	ND	ND
2-methyl naphthalene	not listed	ND	2.3	ND	ND	ND	ND	0.130J	ND	ND	ND	ND	ND
Fluoranthene	146	0.210J	0.063J	ND	0.11J	ND	ND	0.39	ND	0.58	0.19J	0.4	ND
Pyrene	110	0.260J	0.12J	0.026J	0.23J	ND	ND	0.39	ND	0.4	0.15J	0.24J	ND
Acenaphthene	219	ND	ND	ND	ND	ND	ND	0.05J	ND	0.044J	ND	ND	ND
Di benzo furan	not listed	0.010J	ND	ND	ND	ND	ND	0.034J	ND	0.020J	ND		ND
Di ethyl phthalate	2,920	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
phenanthrene	not listed	0.170J	0.086J	ND	0.077J	ND	ND	0.33J	ND	0.45	ND	0.23J	ND
Anthracene	1,100	0.047J	ND	ND	ND	ND	ND	0.086J	ND	0.11J	ND	0.048J	ND
Di-n-butyl phthalate	365	ND	0.027J	ND	0.029J	ND	ND	ND	ND	ND	ND	ND	ND
Fluorene	146	ND	0.067J	ND	ND	ND	ND	0.075J	ND	0.0555	ND	0.026J	ND
3,3-dichlorobenzidine	not listed	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.015J	ND
Benzo(a)anthracene	not listed	0.120J	0.045J	ND	0.073J	ND	ND	0.220J	ND	0.19J	0.092J	0.16J	ND
Chrysene	not listed	0.140J	0.05J	0.023J	0.080J	ND	ND	0.210J	ND	0.24J	ND	0.22J	0.15J
bis(2-ethylhexyl)phthalate	0.608	ND	ND	ND	ND	ND	ND	0.082J	0.130J	ND	ND	0.063J	0.68J
Benzo(b)fluoranthene	not listed	ND	0.077	ND	0.130J	ND	0.065J	0.230J	ND	0.200J	ND	ND	ND
Benzo(a)pyrene	not listed	ND	0.04	ND	0.069J	ND	ND	0.150J	ND	ND	ND	0.21J	ND
Benzo(g,h,i)perylene	not listed	ND	0.054	ND	0.130J	ND	ND	ND	ND	ND	ND	ND	ND
Indeno(1,2,3-cd)pyrene	not listed	ND	0.062	ND	0.083J	ND	ND	ND	ND	ND	ND	ND	ND
Total petroleum hydrocarbon	nonspecific	32	960	160	160	270	<24	1,900	150	3,200	3,100	610	4,600

1GWP-Groundwater Protection-Residential
2ND-not detected, detection limit not available in copies of reference reports
(J)-estimated value
(B)-blank interference

W-Roy F. Weston data
R-Radian data
N-NUS data
G-RE Wright geoprobe data

Table 2.1, continued
Summary of Organic Compounds in Soil at Site FC-2
Kelly AFB, Texas

		Sample ID					
	Risk Reduction1	concentrations in milligrams per kilograms (mg/kg)					
Parameters	Rule Standard #2	REW-2033[G]	REW-2034[G]	REW-2036[G]	REW-2035[G]	REW-2039[G]	REW-2041[G]
Methylene chloride	0.5	ND	ND	ND	ND	ND	ND
Acetone	365	ND	ND	ND	ND	ND	ND
1,2-dichloroethylene	1	ND	ND	ND	ND	MD	ND
2-butanone (MEK)	183	ND	ND	ND	ND	ND	ND
Benzene	0.5	ND	ND	ND	0.005	ND	ND
1,1,1-trichloroethane	20	ND	ND	ND	ND	ND	ND
Toluene	100	ND	ND	ND	ND	ND	ND
Chlorobenzene	10	ND	ND	ND	ND	ND	ND
Ethyl benzene	70	ND	ND	ND	ND	ND	ND
Xylene	1,000	ND	ND	ND	ND	ND	ND
Trichloroethylene	0.5	ND	ND	ND	ND	ND	ND
1,4-dichlorobenzene	7.5	0.120	0.241	ND	4.023	2.629	ND
1,2-dichloro benzene	60	0.326	1.022	ND	4.786	ND	1.58
Naphthalene	146	ND	0.333	3.255	3.134	5.58	1.98
2-methyl naphthalene	not listed	ND	ND	ND	ND	ND	ND
Fluoranthene	146	ND	ND	ND	ND	ND	ND
Pyrene	110	0.049	0.584	ND	0.125	9.456	ND
Acenaphthene	219	ND	ND	ND	ND	ND	ND
Di benzo furan	not listed	ND	ND	ND	ND	ND	ND
Di ethyl phthalate	2,920	ND	ND	ND	ND	ND	ND
phenanthrene	not listed	ND	ND	ND	ND	ND	ND
Anthracene	1,100	ND	ND	ND	ND	ND	ND
Di-n-butyl phthalate	365	ND	ND	ND	ND	ND	ND
Fluorene	146	ND	ND	ND	ND	ND	ND
3,3-dichlorobenzidine	not listed	ND	ND	ND	ND	ND	ND
Benzo(a)anthracene	not listed	ND	ND	ND	ND	ND	ND
Chrysene	not listed	ND	ND	ND	ND	ND	ND
bis(2-ethylhexyl)phthalate	0.608	ND	ND	ND	ND	ND	ND
Benzo(b)fluoranthene	not listed	0.18	ND	0.088	0.303	0.538	2.182
Benzo(a)pyrene	not listed	ND	ND	ND	ND	ND	ND
Benzo(g,h,i)perylene	not listed	ND	ND	ND	ND	ND	ND
Indeno(1,2,3-cd)pyrene	not listed	ND	ND	ND	ND	ND	ND
Total petroleum hydrocarbon	nonspecific	ND	ND	ND	ND	ND	ND

1GWP-Groundwater Protection-Residential
2ND-not detected, detection limit not available in copies of reference reports
(J)-estimated value
(B)-blank interference

W-Roy F. Weston data
R-Radian data
N-NUS data
G-RE Wright geoprobe data

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compounds detected. Sample depth was not included in the preliminary data report. The highest concentration of contaminants were identified southeast of the simulated airplane in the geoprobe samples.

Additional soil gas sampling was also performed by Parsons ES in August 1995 to identify portions of subsurface soil that are depleted of oxygen. Oxygen is depleted in portions of the site where data indicate the presence of higher TPH contaminant concentrations. Floating product was observed in MW F202(FT024MW002). The probable extent of contaminated soils designated for remediation is shown on Figure 2.3.

Contaminants in groundwater exceeded the criteria for standard 2 closures in only 2 samples collected. 1,2-dichloroethane was detected in one sample collected from well TC-11. (NUS, 1992), which is upgradient of the simulated airplane. Benzene was detected at 2.4 mg/L during the first sampling round from MW-F202. No benzene was detected in subsequent sampling rounds. A oily sheen was reported in soils during the construction of MW-F202 (Radian 1988). Limited groundwater data was available for review. Further evaluation of groundwater chemistry data is necessary to assess the existing risk of contaminants which have been detected at the site.

Most of the contaminant concentrations reported in the soil samples collected during previous investigations are below criteria for closure under risk reduction rules, standard number 2 (30 TAC 35 subchapter S), as shown on Table 2.1. However, accelerated contaminant removal from soils using bioventing will reduce the potential of migration to groundwater or surface water pathways.

The concentrations of contaminants in soils with values listed in the risk reduction rules, are currently below the listed residential groundwater protection level (GWP). GWP levels are concentrations of contaminants in soils assumed protective of groundwater considering migration of contaminants in soils to groundwater. Contamination present in subsurface soils may still leach to groundwater and, if determined to be discharging into Leon Creek, may eventually exceed the risk reduction rules closure criteria for standard number 2, residential groundwater/surface water protection levels for risk to surface water receptors. Surface water receptors are the only targets threatened by contamination in the groundwater.

Residential groundwater protection levels were chosen to provide the most conservative comparison with actual detected concentrations in soil. To achieve site closure, it may also be necessary to demonstrate that TPH in site soils is not mobile. The proposed upgrade to the bioventing pilot system is designed to provide the necessary oxygen to stimulate *in situ* biodegradation of petroleum hydrocarbons throughout the entire volume of unsaturated, contaminated subsurface soils at the site.

NOTE:
CROSS SECTION A-A' SHOWN
ON FIGURE 2.2

N

0 50 100 200
FEET

LEGEND

- EXISTING MONITORING WELL
- EXISTING BIOVENTING MONITORING POINT
- EXISTING VENT WELL
- SURFACE SOIL SAMPLE
- INSTALLED SOIL BORING
- GEOPROBE SAMPLE LOCATIONS
- ESTIMATED EXTENT OF CONTAMINATED SOIL

FIGURE 2.3

PROBABLE EXTENT OF SOIL CONTAMINATION DESIGNATED FOR REMEDIATION

Remedial Action Plan
Site FC-2
Kelly AFB, Texas

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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SECTION 3
BIOVENTING PILOT TEST RESULTS

The objectives of the initial bioventing pilot test were to:

- Assess the potential for supplying oxygen throughout the contaminated soil profile;
- To determine the rate at which indigenous microorganisms will degrade petroleum hydrocarbons when stimulated by oxygen-rich soil gas at this site; and
- To evaluate the potential for sustaining these rates of biodegradation until hydrocarbon contamination is remediated below regulatory approved standards (Parsons ES, 1993).

Because bioventing has been demonstrated to be a feasible technology for this site, the pilot test data was used to design a full-scale remediation system to remediate the soils at the site to minimize potential releases to groundwater/surface water pathways and to assure that contaminant levels throughout the site are below regulatory standards.

3.1 TEST CONFIGURATION

The pilot-scale test system installed in December 1992 at Site FC-2 consisted of an air injection vent well (VW) and three MPs. The pilot test location and configuration was based on site investigation data, which indicated that the highest TPH contamination was located near MW F205. This location is southwest of the simulated aircraft which was used during fire training exercises at the site. The three MPs were positioned southeast of the VW at distances of approximately 10, 20, and 35 feet, respectively, to monitor in situ biodegradation rates and to determine radius of oxygen influence and pressure response resulting from air injection at the VW. During drilling, hydrocarbon-contaminated soils were encountered between 10 and 15 feet below ground surface (bgs). Groundwater was measured at approximately 15 feet bgs during pilot test installation in the VW and nearby MW F205.

The air injection VW was screened from 7 to 17 feet bgl to maximize aeration in the vadose soil interval exhibiting greater potential contamination. The screened interval was extended into the top of groundwater to allow for seasonal fluctuations. Screened intervals were place at 4-, 9-, and 13.5-feet bgl in each MP. The VW is located approximately 5 feet southeast of MW F205. Figure 3.1 shows as-built locations of the VW, MPs, and blower system used to conduct the one year pilot test.

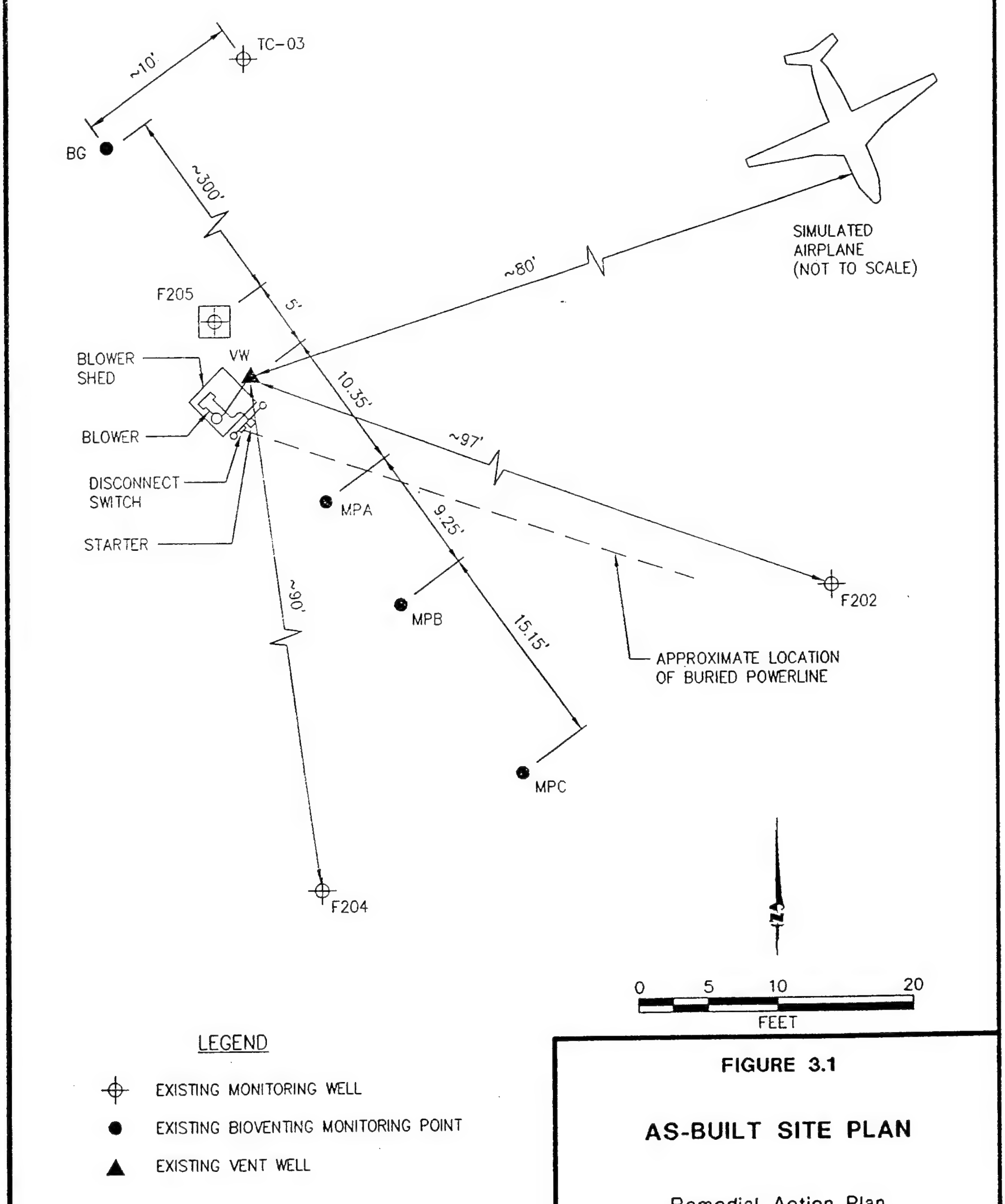

FIGURE 3.1

AS-BUILT SITE PLAN

Remedial Action Plan
Site FC-2
Kelly AFB, Texas

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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3.2 INITIAL SOIL GAS

Prior to any pilot test activities, initial oxygen, carbon dioxide, and total volatile hydrocarbons (TVH) concentrations were measured with portable field instruments. Initial oxygen levels were depleted (less than 1 percent) and carbon dioxide levels were elevated (5.4 to 8.7 percent) in MP soil gas samples collected from 9- and 13-foot bgs intervals. In contrast, soil gas from the background MP (MP-BG), located approximately 300 feet northwest of the VW, contained oxygen at concentrations greater than 16 percent and carbon dioxide less than 3 percent at all measured depths. These initial soil gas results demonstrated that oxygen depletion and carbon dioxide accumulation in contaminated soils resulted from biodegradation of hydrocarbon contaminants rather than naturally occurring soil organic and abiotic processes.

3.3 *IN SITU* BIODEGRADATION RATES

In situ respiration testing was conducted to determine the biodegradation rates of indigenous bacteria in contaminated subsurface soils at Site FC-2. Table 3.1 shows the results of three *in situ* respiration testing events (conducted as part of the bioventing pilot test (initial, 6 months, and 1 year).

Initial biodegradation rates ranged from 3,500 to 8,100 milligrams of TRPH per kilogram of soil per year (mg/kg/year) and averaged 5,625 mg/kg/year. After 6 months of continuous air injection, biodegradation rates decreased to an average of 1,727 mg/kg/year, despite warmer soil temperatures. At the end of the one year testing period, the rates had declined to 930 mg/kg/year. The decline in biodegradation rates is likely due to the reduction of petroleum hydrocarbons remaining in the soils.

3.4 OXYGEN INFLUENCE/AIR PERMEABILITY

An air permeability/radius of oxygen influence test was performed at Site FC-2 to determine the pressure response in the formation induced by pressurizing the vent well and to determine the volume of subsurface soils that could be oxygenated from air injection into a single vent well. Air was injected in to the VW for approximately 23 hours at a rate of approximately 48 cubic feet per minute (cfm) and an average pressure of approximately 0.9 psi. The pressure response measured at each MP screened interval achieved steady state conditions within 5 to 10 minutes, but the test was continued for a 23-hour period to monitor for oxygen influence. The steady state method was used to calculate soil gas permeability values, which averaged 14.7 darcys.

Oxygen level increases were measured at the VW and in screened intervals of MPA and MPB, while decreased oxygen levels were observed at MPC. The decrease in oxygen in MPC screened intervals was attributed to the displacement of soil gas from more contaminated portions of the site (near the VW into formations near MPC), caused by air injection into the VW. The air injection flow rate was reduced during the extended pilot testing. Oxygen measurement made during the 6-month and 1-year testing indicated that oxygen increases were achieved and maintained in all three depths at MPC (35 feet from injection). Based on these results and the measured pressure response, the radius of

Table 3.1
Respiration and Biodegradation Rates at Site FC-2
Kelly AFB, Texas

Location-Depth	Initial = December 1992			6-Month = June 1993			1-Year = January 1994		
	K_o (% O_2/min)	Degradation Rate (mg/kg/year)a/	Soil Temperature (oC)	K_o (% O_2/min)	Degradation Rateb/ (mg/kg/year)	Soil Temperature (oC)	K_o (% O_2/min)	Degradation Rate (mg/kg/year)	Soil Temperature (oC)
MPA-4	NSc/	NS	18.0	NS	NS	26.9	NS	NS	16.7
MPA-13.5	0.040	8100	24.9	0.013	2600	26.4	0.0058	1200	26.4
MPB-9	0.021	3500	NSc/	0.0039	480	NS	0.0023	180	NS
MPB-13.5	0.025	4200	NS	0.0019	230	NS	0.0083	650	NS
MPC-13.5	0.040	6700d/	NS	0.029	3600	NS	0.022	1700	NS

a/ Milligrams of hydrocarbons per kilogram soil per year
b/ Assumes moisture content of the soil is average of initial and final moisture contents.
c/ Not Sampled
d/ Degradation rate calculated assuming MPC-13.5 soil moisture content the same as MPB-13.5.

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influence for a long-term bioventing system at this site exceeds 35 feet at all depths. For design purposes, a 50-foot radius was estimated based on the relationship of oxygen and pressure readings to distance from the injection point.

3.5 SOIL AND SOIL GAS SAMPLING RESULTS

Soil and soil gas samples were collected during the installation of the pilot-scale bioventing system in December 1992 to determine baseline contaminant concentrations at the VW and MP locations. Samples were collected from the same locations in January 1994, after 1 year of pilot-scale soil treatment. The bioventing system was turned off for 10 days prior to collecting soil gas samples to allow the soil gas the reach equilibrium. Significant reductions in petroleum hydrocarbon concentrations occurred over the 1-year study, as shown on Table 3.2.

Soil gas TVH and BTEX were reduced significantly in the three locations sampled. The average reduction in TVH and BTEX was 99.5 and 99.0 percent, respectively. These reductions are likely due to enhanced biodegradation resulting from soil oxygenation, along with minor amounts of volatilization.

Soil TRPH and BTEX concentrations were also significantly reduced during the 1-year study. Average initial TRPH levels were reduced from 1626 mg/kg to 64 mg/kg in the three soil sample locations tested, while BTEX concentrations were reduced by 99.9 percent during the 1-year study. Respiration rates at 1 year, although reduced from initial and 6-month rates, remained fairly high at 12-months considering the low TRPH and BTEX concentrations remaining. Biodegradation rates may be maintained by the contaminants remaining in fringe soils by fluctuations of groundwater contaminated with petroleum hydrocarbons. Based on the limited sampling performed after 1 year of treatment, concentrations of TRPH and BTEX in soils influenced by the pilot test have been reduced to below regulatory criteria for standard number 2 of the Texas Risk reduction rules. However, contamination persists throughout a large portion of the site which has remained untreated.

3.6 RECOMMENDATIONS FOR FULL-SCALE BIOVENTING

Based on the positive results of the one-year bioventing pilot test, AFCEE has provided funding for the design and installation of an expanded bioventing system at Site FC-2. AFCEE has retained Parsons ES to continue bioventing services at Kelly AFB and to complete the design and installation of an expanded bioventing system. Based on the initial pilot test results, available analytical data, and recently completed soil gas screening at Site FC-2, Parsons ES has prepared a conceptual full-scale upgrade design which will employ the existing VW, two existing MWs, and four additional VWs as air injection wells. Three additional MPs will also be installed to ensure oxygen is being delivered to contaminated soils. Section 4 provides details on the design, construction, and operation of the expanded system. A design package has been prepared for construction of the system. The design package is included in the appendix of this report.

Table 3.2
Initial and 1-Year Soil and Soil Gas Analytical Results
Kelly AFB, Texas

Analyte (Units)a/	Sample Location-Depth (feet below ground surface)					
	VW		MPA-13.5		MPC-13.5	
Soil Gas Hydrocarbons	Initialb/	1-Yearc/	Initial	1-Year	Initial	1-Year
TVH (ppmv)	4,200	2.0	16,000	98	17,000	200
Benzene (ppmv)	14.00	<0.002	58	<0.004	43	<0.025
Toluene (ppmv)	7.4	0.02	20	0.28	18	1.5
Ethylbenzene (ppmv)	7	0.01	24	0.093	24	0.35
Xylenes (ppmv)	5.4	0.029	19	0.29	22	0.71
	VW		MPA-14		MPB-14	
Soil Hydrocarbons	Initiald/	1-Yeare/	Initial	1-Year	Initial	1-Year
TRPH (mg/kg)	280	34.1	3,500	73.5	1,100	83.8
Benzene (mg/kg)	<0.38	<0.0006	<1.5	0.001	<0.38	<0.084
Toluene (mg/kg)	9.1	0.0056	12.0	0.027	2.9	0.36
Ethylbenzene (mg/kg)	<0.31	<0.0006	<1.2	0.001	<0.32	<0.084
Xylenes (mg/kg)	11.0	0.0009	40.0	0.0059	15.0	<0.12
Moisture (%)	20.0	16.3	19.4	19.2	20.8	25.9

a/ TRPH=total recoverable petroleum hydrocarbons; mg/kg=milligrams per kilogram;
TVH= total volatile hydrocarbons; ppmv=parts per million, volume per volume.
b/ Initial soil gas samples collected in December 1992.
c/ 1-Year soil gas samples collected in January 1994.
d/ Initial soil gas samples collected in December 1992.
e/ 1-Year soil gas samples collected in January 1994.

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SECTION 4
EXPANDED BIOVENTING SYSTEM

The purpose of the expanded bioventing system is to provide oxygen to stimulate aerobic biodegradation of the remaining soil contamination present at Site FC-2. Based upon the most recent soil gas sampling at the site, the existing VW, four additional air injection VWs, and two converted existing monitoring wells, should be capable of providing oxygen to all remaining oxygen-depleted, unsaturated and contaminated soils at the site. System design details are provided in the appendix (Design Package).

4.1 OBJECTIVE

Following its implementation, the primary objectives of the expanded bioventing system will be to:

- optimize the system to fully aerate areas at the site designated for bioventing remediation;
- monitor the system to ensure continuous operation;
- reduce the existing contaminant levels to below acceptable regulatory cleanup criteria;
- by removing the contaminant source from vadose soils, eliminate the potential for contamination to migrate and adversely affect ground water quality at this site; and
- provide the most cost-effective remediation alternative for this site.

4.2 BASIS OF DESIGN

Additional soil gas sampling was performed by Parsons ES on August 31, 1995 to identify portions of the site that are depleted of oxygen. Anoxic conditions in subsurface soil gas is indicative of significantly contaminated soils and high biological activity. Air injection VWs should be placed in oxygen depleted soils to aerate contaminated zones and stimulate aerobic biodegradation. Soil gas screening results from the existing groundwater MWs provides an indication of the potential benefit of converting existing MWs into VWs.

The field work included measuring soil gas oxygen, carbon dioxide, and hydrocarbon levels at the existing VW, MPs, and from all adjacent groundwater MWs in area. The blower's electrical fuses had been removed from the site, so the blower was out of

operation for several months prior to sampling. Sampled MWs, MPs and the VW were purged, and soil gas oxygen, carbon dioxide, and TVH concentrations were measured using portable gas analyzers, as described in the technical protocol document (Hinchee et al., 1992). Only six active MWs remain in the immediate vicinity of Site FC-2. The remaining MWs have been abandoned or are considered outside and upgradient of contamination (figure 4.1). Table 4.1 summarizes the initial soil gas chemistry results at the six MWs, one vent well, and twelve MP depths at site FC-2. The results showed that anaerobic soil gas conditions exist throughout the site, primarily to the east and southeast of the existing pilot test system. Well number FT024MW002 (F202) has a locking cap that prevented collection of a soil gas sample, but a significant thickness of floating hydrocarbons was observed (6-12 inches).

4.3 SYSTEM DESIGN

The proposed upgrade to the existing bioventing system will incorporate the existing VW, four new VWs, and the conversion of two existing MWs into VWs. Three new monitoring points will also be constructed to monitor soil gas at the site. The two MWs proposed for conversion to VW are F202, and E309. These wells are 2 inches in diameter and are screened with 0.010 inch slot from approximately 13 to 25 feet bgl. Four additional VWs will be installed across the site to ensure proper O_2 influence throughout the area of the presumed soil contamination. The new VWs will be 2-inches in diameter and will be screened with 0.040 inch slot from 7 to 19 feet bgl. Figure 4.2 shows the proposed locations of the converted VWs, new VWs, and new monitoring points with the estimated radius of influence. Trenchline configuration and other design detail are included in the figures provided in the appendix. Where applicable, standard technical specifications for well construction, sampling and analysis, and data management will be followed.

The vent wells will be manifolded using 2"-diameter, schedule 80 PVC as the conduit for the injected air to flow from the blower to the proposed VWs. The piping will be connected to the 2.5 hp regenerative blower that was used for the pilot test and will be set at a depth of 18 inches beneath the ground surface. A separate flow control valve (manual) and flow measurement port will be included in the line connecting each VW to allow adjustment of the air flow to each VW. The blower and valving will be housed in weatherproof enclosures for protection from the elements and for security purposes.

Based on data collected during the initial pilot test, a maximum injection rate of 10-15 cfm at each VW should be sufficient to supply oxygen to the remaining contaminated soils and sustain *in situ* fuel biodegradation. The radius of oxygen influence around each VW was estimated to extend 50 feet at 10 scfm, based on the data collected during the initial pilot testing. The VW locations were selected to make use of existing monitoring wells and to provide coverage of contaminated soils estimated in Figure 2.3. A spacing of approximately 90 feet between VWs is planned.

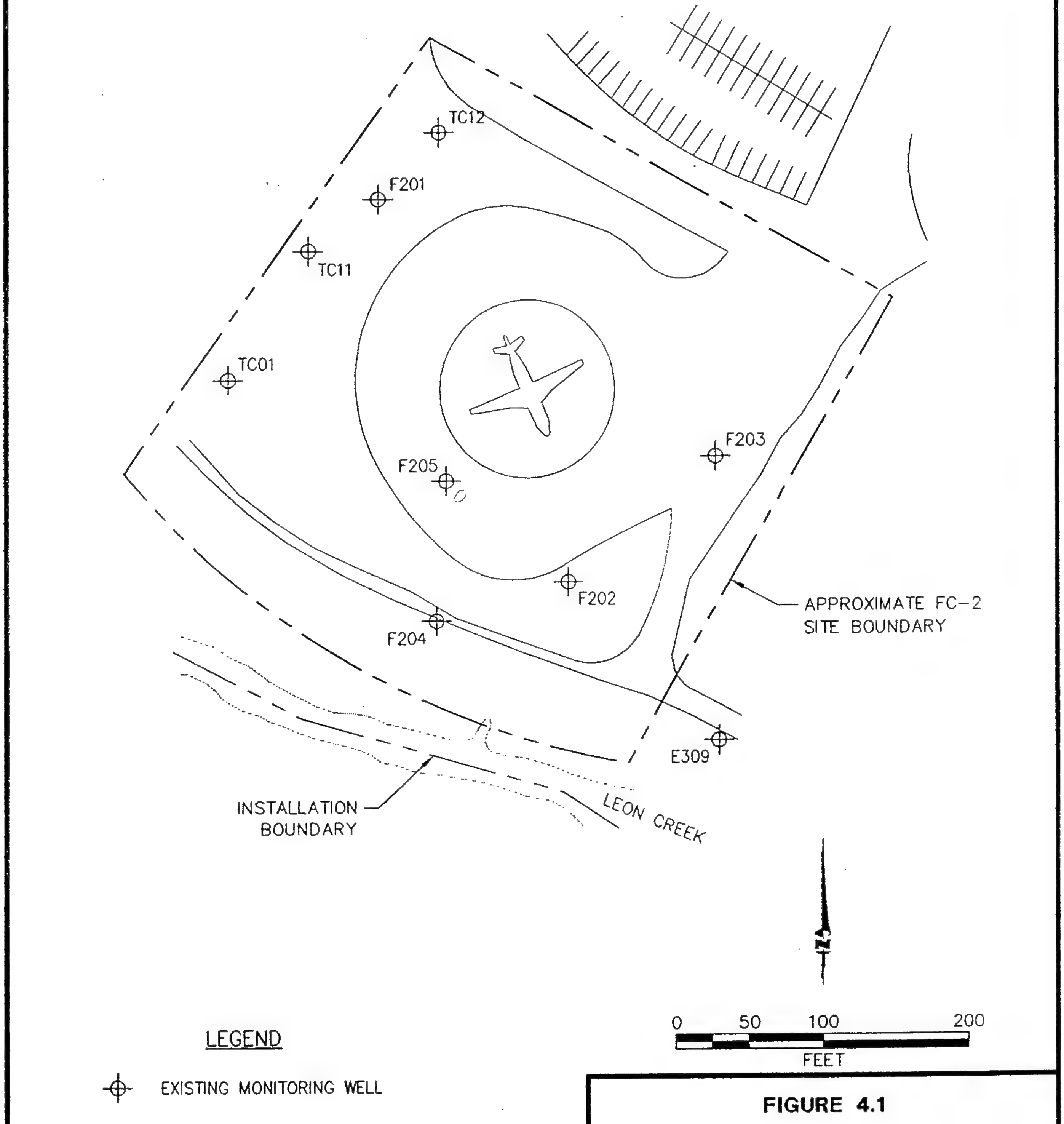

FIGURE 4.1

ACTIVE MONITORING WELLS

Remedial Action Plan
Site FC-2
Kelly AFB, Texas

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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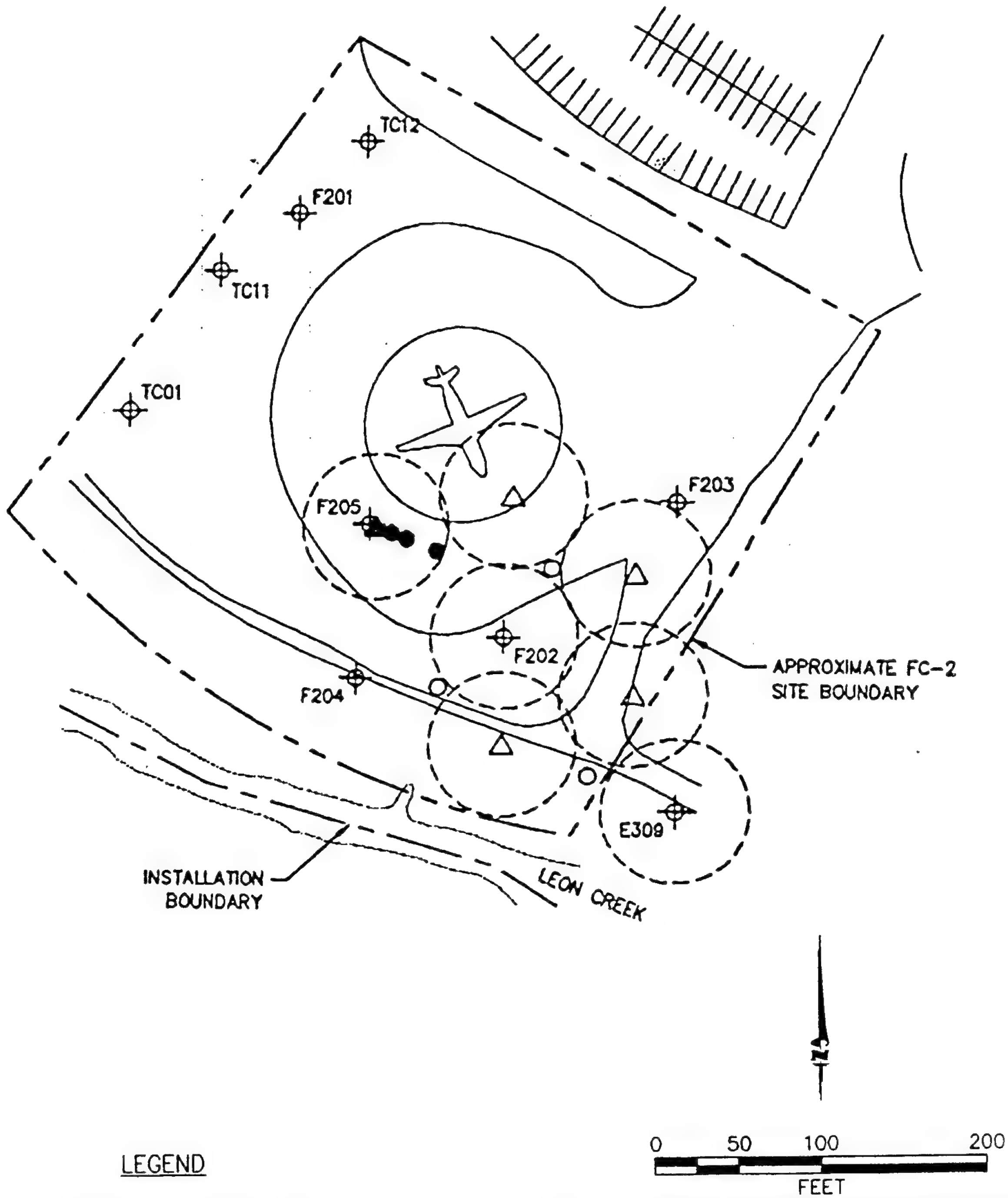
Table 4.1
Site FC-2
Soil Gas Survey
Conducted 31 August 1995
Kelly AFB, Texas

Measuring Point	Depth (FT)	O_2(%)	CO_2(%)	Field TVH (ppm)	Comments
F205	19.82	0.0	13.0	3,000	
F204	18.56	11.5	9.0	150	
F202	19.84	-	-	-	Free product detected in groundwater
F203	20.42	1.0	10.5	5,000	
E309	14.23	0.0	12.0	6,000	
TC-01	18.47	10.0	8.5	350	
VW	7-19	6.0	10.0	1,300	
MPA	4	12.0	6.0	150	
MPA	9	6.5	10.0	200	
MPA	13.5	0.0	16.0	1,200	
MPB	4	15	5.0	20	
MPB	9	0.0	14.0	600	
MPB	13.5	1.7	10.0	500	
MPC	4	11.0	7.0	150	
MPC	9	0.0	17.0	5,000	
MPC	13.5	0.0	17.0	4,000	



LEGEND

- EXISTING MONITORING WELL
- PROPOSED BIOVENTING MONITORING POINT
- EXISTING BIOVENTING MONITORING POINT
- PROPOSED VENT WELL
- EXISTING VENT WELL
- ESTIMATED RADIUS OF INFLUENCE

FIGURE 4.2

PROPOSED FULL SCALE SYSTEM CONFIGURATION

Remedial Action Plan
Site FC-2
Kelly AFB, Texas

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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4.4 CONSTRUCTION SCHEDULE

Following review and approval of the system upgrade work plan by AFCEE/ERT, and Kelly AFB, field work will begin. The following schedule for the upgrade is contingent upon timely approval of this work plan:

Event	Date
Draft Work Plan and Design Package to AFCEE/ERT and Kelly AFB	December 6, 1995
Final Work Plan and Design Package to AFCEE/ERT, Kelly AFB and TNRCC	January 3, 1996
Approval of Work Plan/Notice to Proceed	January 8, 1996
Begin Field Activities/Construction of Expanded System	January 9, 1996
Complete Construction/System Startup	February 2, 1996

4.5 SYSTEM OPERATION AND MONITORING

Following system installation, preparation of an operation and maintenance (O&M) plan, monitoring plan, and as-built system drawings will be prepared.

4.5.1 System Operation

At startup of the full-scale system, it will be necessary to optimize the air injection rate and to ensure proper operation of the blower system. Flow rate optimization is accomplished by gradually increasing the flow rate to each VW until soil gas oxygen concentrations at all MP depth intervals reach a minimum concentration of approximately 10 percent. O_2 levels in excess of 10 percent at the outer MPs may indicate that the volume of air passing through the soil exceeds the biological O_2 utilization. The blower will be checked to ensure that it is producing the required flow rate and pressure for air injection.

O&M requirements for the proposed bioventing system are minimal. The regenerative blower is virtually maintenance-free. The only recurring maintenance required is a monthly check of the air filter, which is generally replaced when a pressure difference of 10 to 15 inches of water across the inlet filter is reached. The time period between filter changes is dependent on site conditions, and is typically every three to six months. The O & M manual will further detail operation requirements.

4.5.2 System Monitoring

Monitoring of the bioventing system will include weekly system checks of the blower operation, including outlet pressures, inlet vacuum, and exhaust temperature. The weekly system checks will be performed by Kelly AFB technicians. Five soil samples will be collected during installation activities. One sample will be collected from the identified contaminated zone encountered in each of the borings drilled for new MP

installation and two of 4 new vent well installations. Soil samples will be analyzed for BTEX, TPH, and polycyclic aromatic hydrocarbons (PAHs). Five soil gas samples will also be collected to establish baseline oxygen and carbon dioxide levels by field screening and TPH and BTEX concentrations by method TO-3 (at least one from each new MP). Soil gas sampling intervals will be determined in the field based on soil gas oxygen screening results. If still present, a sample of the floating hydrocarbons in well F202 will be collected and analyzed to characterize BTEX and PAH content of the product, in lieu of one vent well soil sample. Additionally, system performance monitoring by Parsons ES will include initial *in situ* respiration testing at three MPs during installation and a site visit after one year of system operation to conduct a comprehensive system check to ensure that O_2 continues to reach all MPs in the contaminated soils. A 12-month *in situ* respiration (ISR) test at the MPs may also be performed to ensure that biodegradation is continuing at acceptable levels. Soil gas samples will also be collected from previously sampled MPs and re-analyzed for BTEX and TVH using U.S. Environmental Protection Agency (EPA) laboratory method TO-3.

Prior to performing the 1-year respiration tests and soil gas sampling, the blower will be turned off for 30 days to allow soil gas to equilibrate so 1-year data can be compared to initial soil gas data. Air will be injected into VWs or MPs for 20 hours, and then shut off. O_2 uptake will be monitored in the MPs for approximately 72 hours to measure the rate at which O_2 decreases in the soil gas. This data will then be used to estimate the current biodegradation rates and to evaluate the progress of contaminant removal and system effectiveness. As the fuel in the soil is depleted, the respiration activity of the indigenous microorganisms is reduced, and slower O_2 utilization rates result. The use of oxygen utilization and soil gas chemistry as indicators of remaining contaminant concentration decreases the likelihood of premature closure soil sampling events.

System monitoring and ISR test data will be analyzed to determine the progress of soil remediation. Estimates of contaminant reduction and time remaining to complete soil remediation will be based on the data collected during the respiration tests (O_2 utilization rates), quantitative estimates of the long-term biodegradation rates (Kb), and decreases in soil gas concentrations. If soil gas data indicates that the soils have been sufficiently remediated, a soils sampling plan will be implemented to close the site in accordance with standard 2 of the TNRCC risk reduction rules. A separate site closure plan will be prepared following completion of the remediation to propose closure sampling.

The monitoring schedule for the full-scale system will be:

Event	Frequency
Blower Vacuum/Pressures and Temperatures	Bi-weekly
Respiration Testing	Annual
Soil Gas Sampling	Annual
Soil Sampling	As Required[a/]

a/ Soil sampling will be performed during confirmation closure sampling at project completion.

SECTION 5
HANDLING OF INVESTIGATION DERIVED WASTES (IDW)

Disposition of drill cuttings will be based on physical appearance (i.e. odor and staining) and field soil headspace screening results. Uncontaminated soil will be spread on the ground surface adjacent to each boring. Potentially contaminated drill cuttings will be placed in storage drums and transported to a designated location at Kelly AFB. IDW management procedures will be performed in accordance with Kelly AFB technical specifications.

SECTION 6
BASE SUPPORT REQUIREMENTS

The following Base support is needed prior to the arrival of the drilling subcontractor and the Parsons ES system installation team:

- assistance in obtaining drilling and digging permits;
- gate passes and security badges for the Parsons ES bioventing team and the drilling subcontractor; and
- vehicle passes for one Parsons ES truck, and drill rig and supply truck.

During initial testing and system installation, the following Base support is needed:

- approval of selected decontamination area at site FC-2 where the driller can clean augers between borings;
- guidance to be followed for management of IDW; and
- a potable water supply for well construction and decontamination activities.

During the 1-year extended pilot test, base personnel will be required to perform the following activities:

- Check the blower systems once every two weeks to ensure that they are operating, and to record the air injection pressure and other parameters. Parsons ES personnel will provide a brief training session on this procedure.
- If a blower stops working, notify Mr. Brian Vanderglas or Kyle Caskey of Parsons ES - Austin at (512) 719-6000, Mr. John Ratz of Parsons ES - Denver at (303) 831-8100, or Lt. MaryAnn Jenner of AFCEE at (210) 536-4364.
- Arrange site access for a Parsons ES technician to conduct respiration testing and soil gas sampling approximately 1 year after the initial pilot testing and system installation.

SECTION 7
KEY POINTS OF CONTACT

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TNRCC
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Austin, Texas 78753
(512) 239-2361

<u>Analytical Laboratories</u>

Soil Gas Samples
Debbie Pearce
AirToxics, Inc.
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Folsom, CA 95630
(800) 985-5955

Soil Samples
Jacqueline Mayhew
Inchcape Testing Services
1089 E. Collins Blvd.
Richardson, TX 75081
(214) 238-5591

Drilling/Trenching Subcontractor
Allan Balderas
Jones Environmental Drilling, Inc.
413 FM 1103
Cibolo, TX 78108
(210) 658-7063

SECTION 8
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APPENDIX
DESIGN PACKAGE

CONSTRUCTION DRAWINGS FOR

EXPANDED BIOVENTING SYSTEM
SITE FC-2
KELLY AIR FORCE BASE

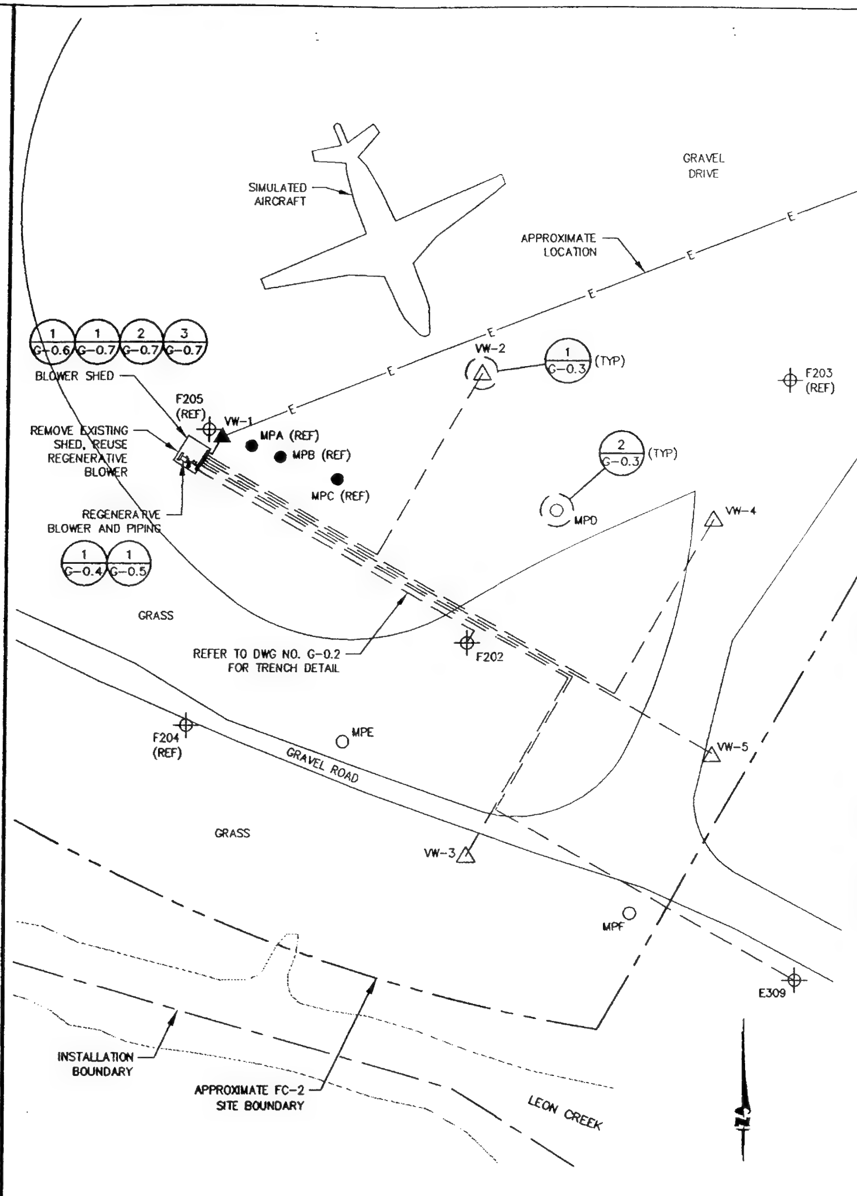
PREPARED FOR

AFCEE

NOVEMBER 1995

DRAWING INDEX

DRAWING NO	DRAWING NAME
G-0.1	TITLE SHEET AND SITE LAYOUT
G-0.2	LEGEND AND STANDARD TRENCH DETAIL
G-0.3	VENT WELL AND MONITORING POINT STANDARD DETAILS
G-0.4	BLOWER P & ID
G-0.5	BLOWER PIPING LAYOUT DETAIL
G-0.6	BLOWER SHED BASE AND SUPPORT DETAIL
G-0.7	BLOWER SHED FIELD INSTALLATION DETAIL AND BLOWER SHED CONSTRUCTION DETAIL



SITE LAYOUT
SCALE: 1" = 40'

Job No. 726876.19142			
Designed RAF			
Drawn MW			
Checked			
Reviewed			
Approved			
Reg No	A	11/17/95	65% DESIGN
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AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE (AFCEE)
EXPANDED BIOVENTING SYSTEM
SITE FC-2
KELLY AIR FORCE BASE

TITLE SHEET AND SITE LAYOUT

DRAWING NO G-0.1 REV -

95DN1462, 11/27/95 at 13:20

ABBREVIATIONS

AIJ	AIR INJECTION
APPROX	APPROXIMATE
ASTM	AMERICAN SOCIETY OF TESTING AND MATERIALS
&	AND
@	AT
CBM	CENTER BACK MOUNT
CLR	CLEAR
DIA	DIAMETER
EB	EXPLORATORY BORING
ECC	ECCENTRIC
EW	EACH WAY
FOT	FLAT ON TOP
FPT	FEMALE PIPE THREAD
FT	FOOT
GALV	GALVANIZED STEEL
ie	FOR EXAMPLE
LM	LOWER MOUNT
MAX	MAXIMUM
MIN	MINIMUM
MP	MONITORING POINT
MPT	MALE PIPE THREAD
NO, #	NUMBER
NTS	NOT TO SCALE
OC	ON CENTER
OD	OUTSIDE DIAMETER
PVC	POLYVINYL CHLORIDE
PW	PROPOSED WELL
RED	REDUCER
REF	REFERENCE
SCH	SCHEDULE
S	SOCKET
SPVC	SLOTTED POLYVINYL CHLORIDE
TYP	TYPICAL
VW	VENT WELL
W/	WITH
WN	WELD NECK

SYMBOLS

F-204	EXISTING MONITORING WELL
MPC	EXISTING BIOVENTING MONITORING POINT
MPD	PROPOSED BIOVENTING MONITORING POINT
VW-1	EXISTING VENT WELL
VW-2	PROPOSED VENT WELL
— — —	PROPOSED HEADER PIPE TO VENT WELL
—E—E—	BURIED ELECTRICAL CONDUIT

SECTION DESIGNATION — SECTION NAME

(A / X) **SECTION CUT**

SCALE: NTS

DRAWING OF ORIGIN — SCALE

DETAIL NO — DETAIL NAME

(1 / X) **DETAIL DESCRIPTION**

SCALE: NTS

DRAWING OF ORIGIN — SCALE

MATERIAL LEGEND

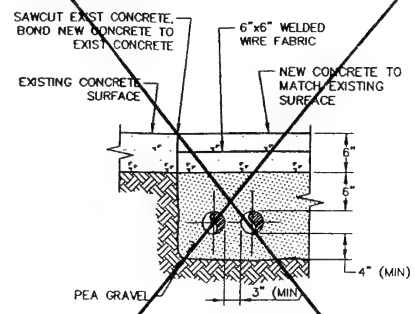
- ASPHALT
- BENTONITE
- BENTONITE/CEMENT GROUT (EXISTING)
- BENTONITE PELLETS
- BUILDING (EXISTING)
- COMPACTED BACKFILL
- COMPACTED BASE STONE
- CONCRETE
- PEA GRAVEL
- SAND
- UNDISTURBED SOIL

PIPE MATERIAL

CS	CARBON STEEL
GALV	GALVANIZED STEEL
PVC	POLYVINYL CHLORIDE
SPVC	SCREENED POLYVINYL CHLORIDE

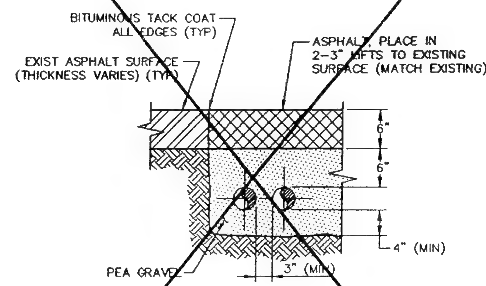
PIPE SERVICE

AIJ	AIR INJECTION
BIV	BIOVENTING
DR	DRAIN



(1 / –) CONCRETE REPLACEMENT DETAIL

SCALE: NTS



(2 / –) ASPHALT REPLACEMENT DETAIL

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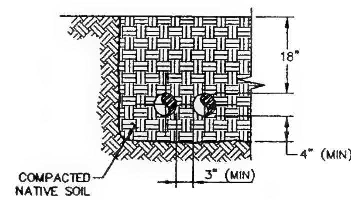

(3 / –) SOIL COVER REPLACEMENT DETAIL

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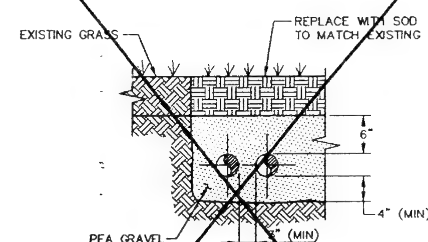

(4 / –) GRASS COVER REPLACEMENT DETAIL

SCALE: NTS

Job No.	726876.19142
Designed	RAF
Drawn	MW
Checked	JWK 11-28-95
Reviewed	RAF 11/28/95
Approved	
Reg No	
Date	

Rev	Date	Description	By
A	11/17/95	65% DESIGN	

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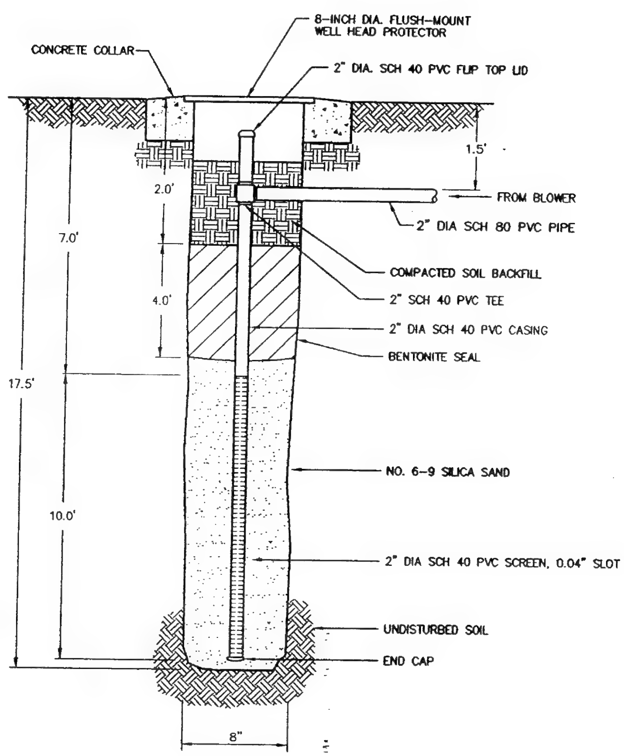
AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE (AFCEE)

EXPANDED BIOVENTING SYSTEM
SITE FC-2
KELLY AIR FORCE BASE

LEGEND AND STANDARD TRENCH DETAILS

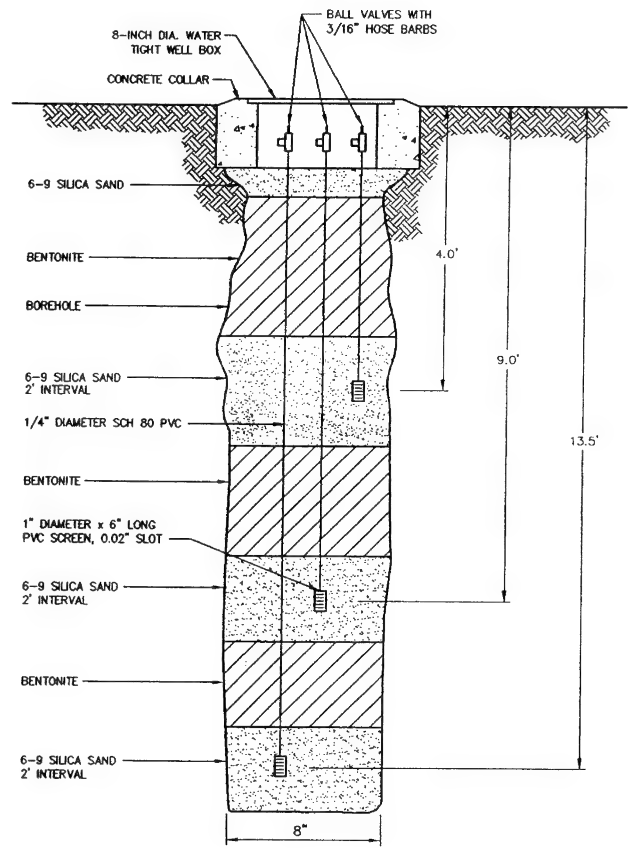
DRAWING NO G-0.2 REV -

95DN1463, 11/27/95 at 14:00



1 VENT WELL (VW) DETAIL

SCALE: NTS



2 MONITORING POINT (MP) DETAIL

SCALE: NTS

Job No. 726876.19142			
Designed RAF			
Drawn MW			
Checked			
Reviewed 11/29/95			
Approved			
Reg No	A	11/17/95	65% DESIGN
Date	Rev	Date	Description	By

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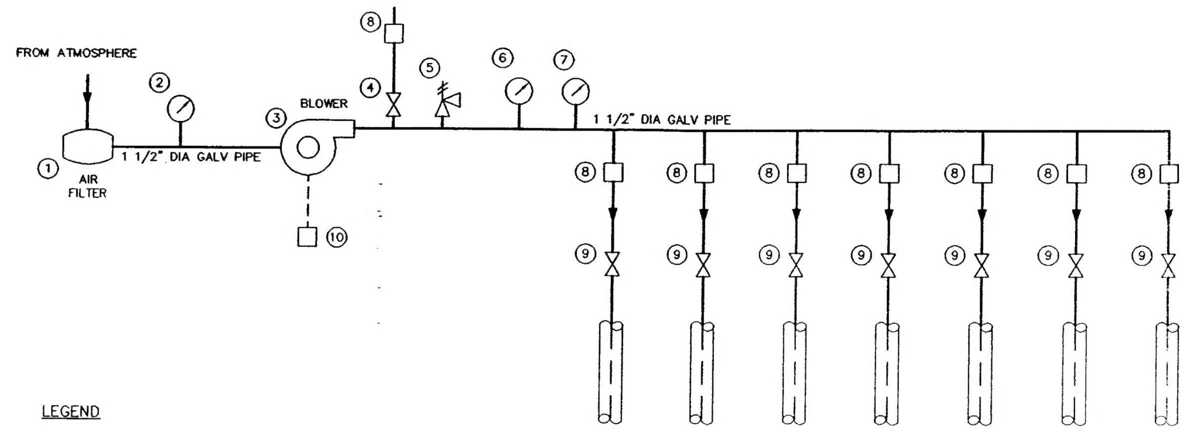
AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE (AFCEE)

EXPANDED BIOVENTING SYSTEM
SITE FC-2
KELLY AIR FORCE BASE

VENT WELL AND MONITORING POINT STANDARD DETAILS

DRAWING NO G-0.3 | REV -

95DN1464, 11/27/95 at 04:15



LEGEND

1. INLET AIR FILTER – SOLBERG F-30P-150, REPLACEMENT ELEMENT 30P
2. VACUUM GAUGE – WIKA 611.10, 2 1/2" DIA., 0–30" H_2O, 1/4" NPT, LM (Part No. 9852344)
3. BLOWER – GAST® 2.5HP R5125Q-60, 130 CFM AT 15" H_2O PRESSURE (EXISTING)
4. MANUAL PRESSURE RELIEF (BLEED) VALVE – 1 1/2" GATE
5. AUTOMATIC PRESSURE RELIEF VALVE – GAST AG258, SET TO RELEASE AT 40" H_2O PRESSURE
6. TEMPERATURE GAUGE – ASHCROFT, 0–250°F, 1/2" NPT, CBM (Part No. 2A606 FROM GRAINGER)
7. PRESSURE GAUGE – WIKA 611.10, 2 1/2" DIA., 0–100" H_2O, 1/4" NPT, CBM (Part No. 9851810)
8. FLOW MEASURING PORT FITTED WITH PLUG (1/4" x 1/8" NPT BRASS REDUCING BUSHING, 1/8" NPT BRASS PLUG)
9. FLOW CONTROL VALVE – 1 1/2" GATE
10. STARTER (EXISTING)

BLOWER PIPING AND INSTRUMENTATION DIAGRAM

SCALE: NTS

Job No. 726876.19142	
Designed RAF	
Drawn MW	
Checked	
Reviewed	11/28/95
Approved	
Reg No	
Date	

Rev	Date	Description	By
A	11/17/95	85% DESIGN	

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AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE (AFCEE)

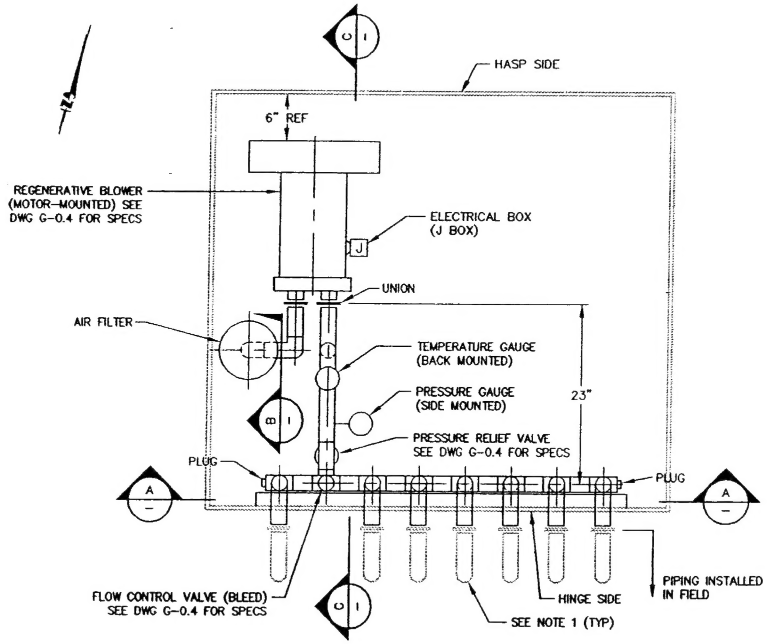
EXPANDED BIOVENTING SYSTEM
SITE FC-2
KELLY AIR FORCE BASE

BLOWER P & ID

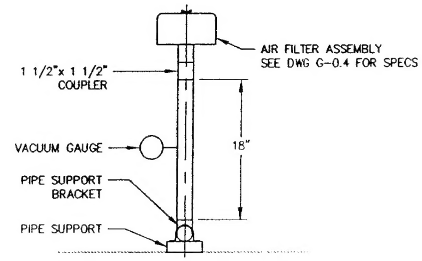
DRAWING NO	REV
G-0.4	-

NOTES:

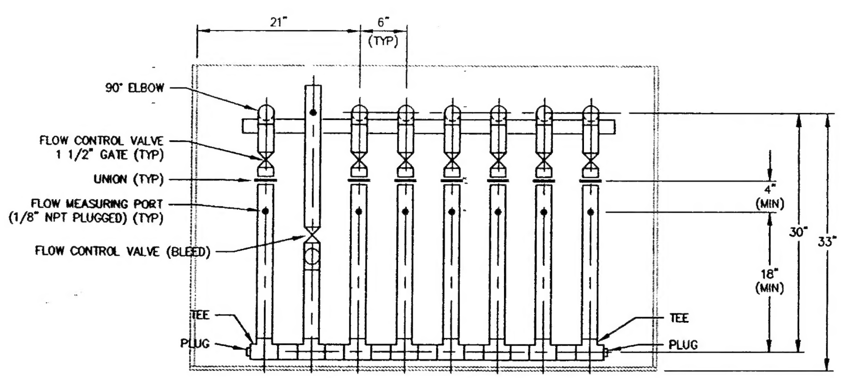
1. SHOP CORE HOLES TO PIPING DIMENSIONS
2. ALL PIPING 1 1/2" DIA. GALVANIZED STEEL, UNLESS OTHERWISE NOTED
3. SEE DRAWING G-0.7 FOR BLOWER BUILDING DETAILS



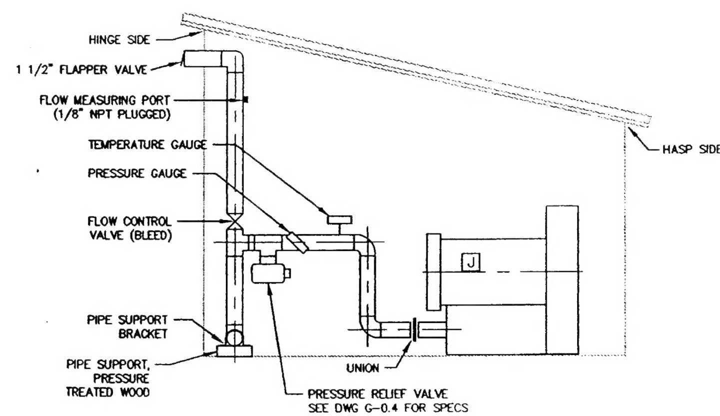
1 BLOWER PIPING LAYOUT PLAN DETAIL
3/4" = 1'-0"



B BLOWER INLET PIPING SECTION
3/4" = 1'-0"



A MANIFOLD DETAIL SECTION
3/4" = 1'-0"



C BLOWER OUTLET PIPING SECTION
3/4" = 1'-0"

Job No. 726876.19142			
Designed RAF			
Drawn MW			
Checked [illegible] 11-23-95			
Reviewed RAF 11/28/95			
Approved	A	11/17/95	65% DESIGN
Reg No	Rev	Date	Description
Date			By

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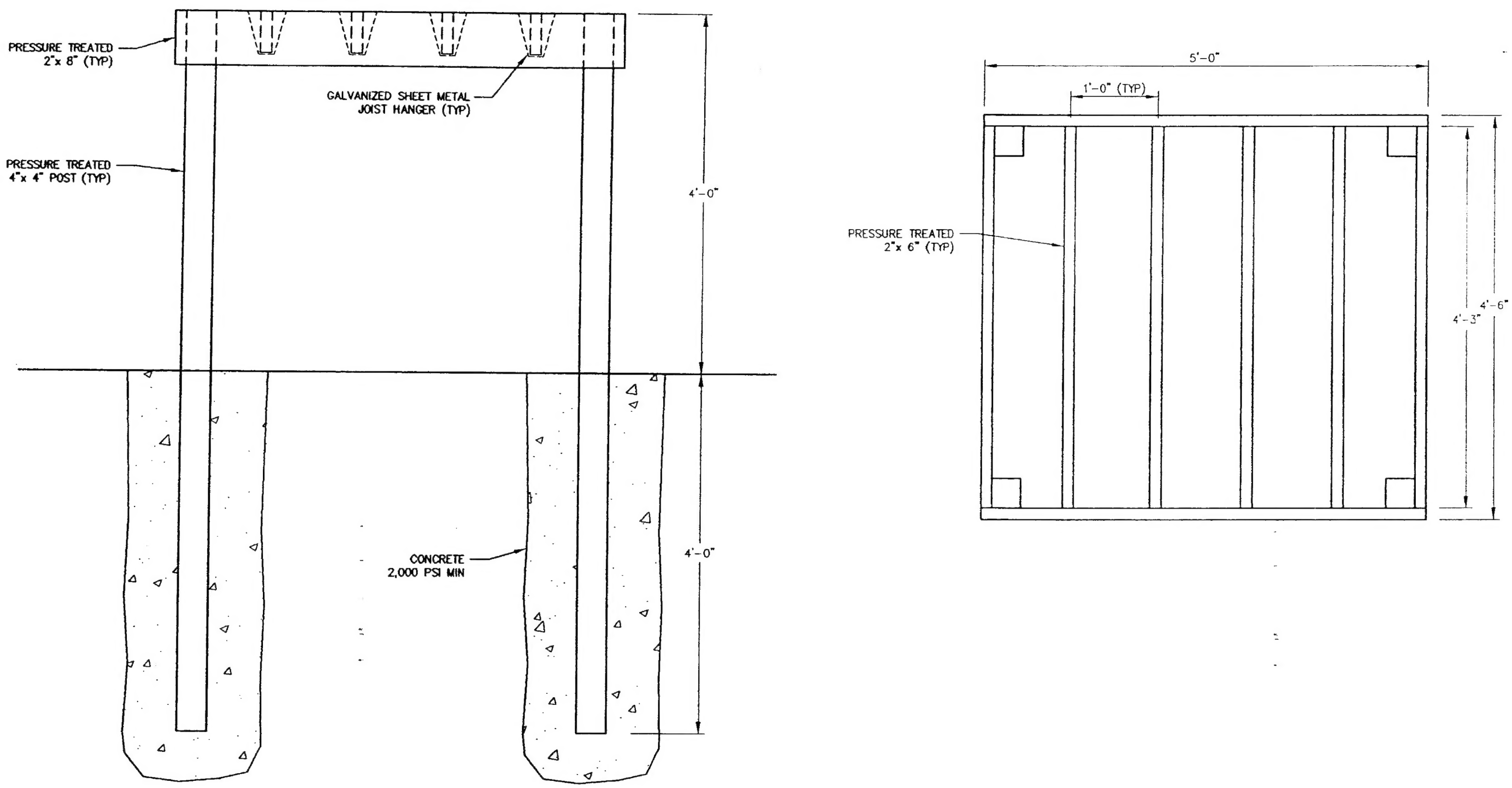
AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE (AFCEE)

EXPANDED BIOVENTING SYSTEM
SITE FC-2
KELLY AIR FORCE BASE

BLOWER PIPING LAYOUT DETAIL

DRAWING NO G-0.5 | REV -



1 BLOWER SHED BASE AND SUPPORT DETAIL

3/4" = 1'-0"

Job No.	726878.19142
Designed	RAF
Drawn	MW
Checked	11-23-95
Reviewed	11/21/95
Approved	
Reg No	
Date	

Rev	Date	Description	By
A	11/17/95	65% DESIGN	

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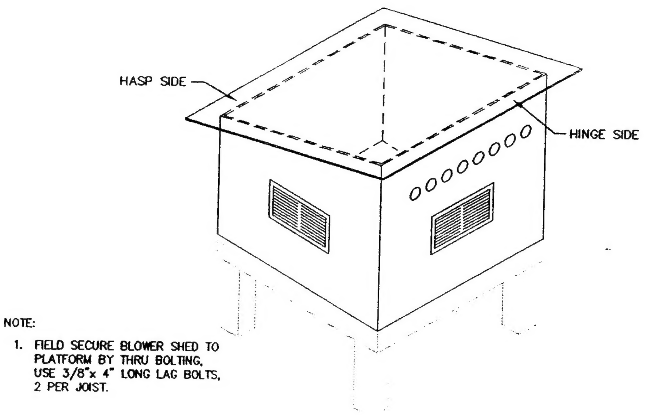
AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE (AFCEE)

EXPANDED BIOVENTING SYSTEM
SITE FC-2
KELLY AIR FORCE BASE

BLOWER PIPING LAYOUT DETAIL

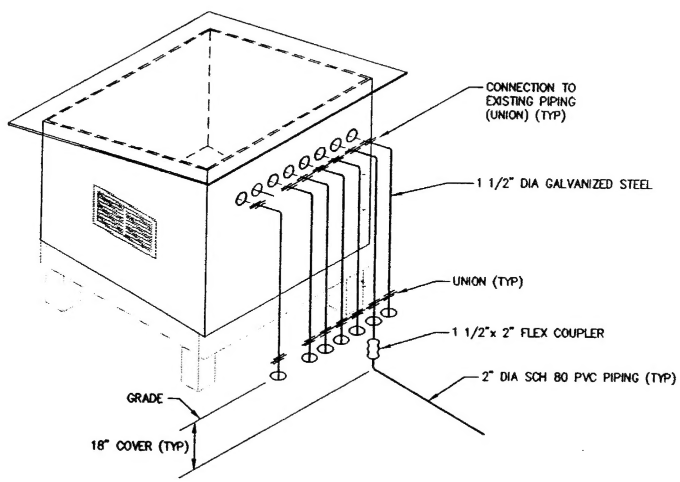
DRAWING NO **G-0.6** REV -



NOTE:
1. FIELD SECURE BLOWER SHED TO PLATFORM BY THRU BOLTING, USE 3/8"x 4" LONG LAG BOLTS, 2 PER JOIST.

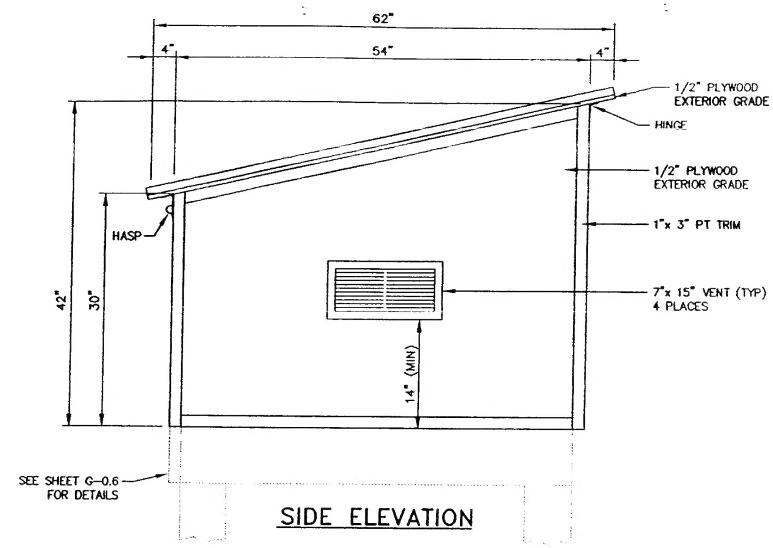
(1) BLOWER SHED FIELD INSTALLATION DETAIL

NOT TO SCALE

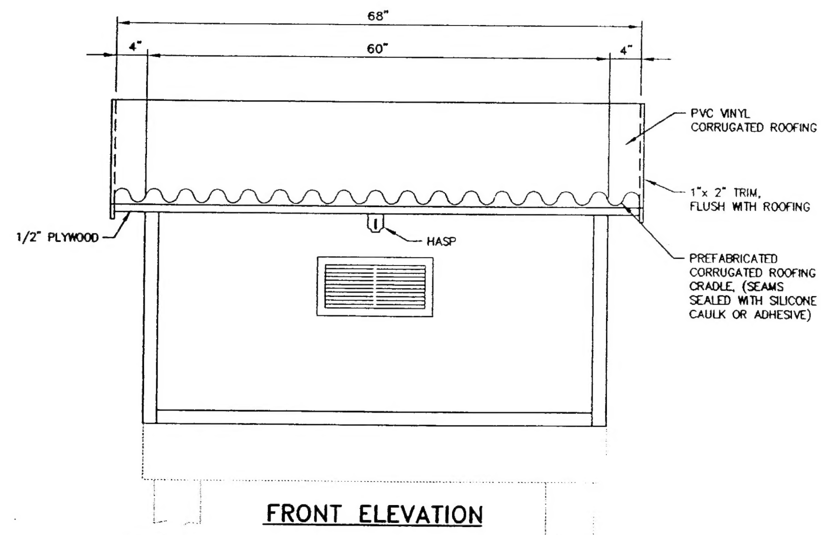


(2) TYPICAL MANIFOLD DISCHARGE PIPING LAYOUT

NOT TO SCALE



SIDE ELEVATION



FRONT ELEVATION

NOTES:
1. 2"x 2" FRAME CONSTRUCTION
2. FLOOR CONSTRUCTED OF 3/4" EXTERIOR GRADE PLYWOOD
3. ROOF CONSTRUCTED OF 1/2" EXTERIOR GRADE PLYWOOD COVERED WITH PVC VINYL CORRUGATED ROOFING

(3) BLOWER SHED CONSTRUCTION DETAIL

3/4" = 1'-0"

Job No. 726876.19142			
Designed RAF			
Drawn MW			
Checked [illegible] 11/28/95			
Reviewed [illegible] 11/28/95			
Approved			
Reg No	A	11/17/95	65% DESIGN
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AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE (AFCEE)

EXPANDED BIOVENTING SYSTEM
SITE FC-2
KELLY AIR FORCE BASE

BLOWER SHED FIELD INSTALLATION DETAIL AND BLOWER SHED CONSTRUCTION DETAILS

DRAWING NO G-0.7 | REV -

95DN1467, 11/28/95 at 14:50